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ABSTRACT

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The Effects of a Constructivist-Oriented Mathematics Classroom on Student and Parent Beliefs About and Motivations Towards Being Successful in Mathematics

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Abstract

The effects of a constructivist-oriented curriculum on the beliefs and motivations of students and parents toward being successful in mathematics were examined. Specifically, the question of the influence of constructivist activity on individual beliefs in and motivations toward task-orientation rather than ego- or work-avoidance-orientation was analyzed with respect to student attitudes and to the attitudes of the students' parents. The results indicated that project students were significantly more likely to orient themselves toward the task and internal schemes of reward rather than external motivators. The parents of project students, on the other hand, demonstrated an orientation in beliefs toward ego orientation and work avoidance, even when these parents participated in activities to inform them of constructivist ideology and focus. These results are interpreted with regard to the literature on the larger social and cultural forces which shape efforts at curriculum reform, and to the potential effects of the indicated beliefs on reform efforts, specifically the propensity of parents to exert pressure to control the nature and direction of reform efforts in general.

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THE EFFECTS OF A CONSTRUCTIVIST-ORIENTED MATHEMATICS CLASSROOM ON STUDENT AND PARENT BELIEFS ABOUT AND MOTIVATIONS TOWARD BEING SUCCESSFUL IN MATHEMATICS

The past decade has witnessed profound changes in the field of mathematics education, both in the theoretical bases on which research is conducted as well as in the curricular areas of methodology and content. Two co-emerging movements have served as the backdrop for these changes in philosophy and practice, and have thus re-framed all previous claims of effective epistemology. Research conducted in the area of constructivism along with recommendations drawn up by the National Council of Teachers of Mathematics (NCTM) have provided the theoretical underpinnings for the changes taking place, as well as a direction toward which resultant reform attempts should be aimed. It is important with respect to these new and emerging paradigms in knowledge acquisition, curriculum content and methodology to examine affective measures of achievement as well as cognitive ones. This study examined the question do constructivist changes in the classroom have an effect on student goals and motivations toward learning math? It further examined the related question of how these changes might affect parent attitudes toward mathematics, and their resultant attitudes toward mathematics reform. The results of these analyses were then used to examine how these parent perceptions and attitudes about appropriate mathematics classroom activity impact the actions and intent of the reforms. The discussion of these results serve to situate mathematics reform efforts within a larger social, political and cultural context.

Literature Review

Changes in Theory Within Mathematics Education

Constructivism has emerged within the past decade as the dominant epistemology of mathematics teaching and learning. It is a theory which has drawn heavily from the philosophies of Piaget (1937), Kant (1959) and Dewey (1960), as well as theories developed within the philosophy of science by Kuhn (1970). The work of Ernst von Glasersfeld (1991) has translated these larger theories to a theory of mathematics education which is profound in ideology and expansive in scope.

Modern constructivist theorists have recognized the same crisis in paradigm within mathematics education which Kuhn outlined within physical science. Kuhn recognized that the occurrence of discrepant events, or " anomalies", within the realm of "accepted science" often resulted in a "crisis" in which the accepted paradigm is unable to provide explanations or answers for the inconsistencies. It is this crisis situation which requires that an alternate theory be developed which will be inclusive of all known "anomalies."

This theoretical framework lends itself to interpretation within mathematics education, in which large portions of the population have found it acceptable to claim that they are mathematically illiterate (Lochhead, 1992), and in which most minority groups are decidedly under represented in the field (Powell, 1990). The "crisis" here has been the recognition that these anomalies of under-representation exist, and that there have been no effective paradigms which were effective in including them.

Constructivism bears the marks of a paradigmatic shift in belief systems. Within this epistemology, individual learning (or "knowing") (Smith, 1995) is seen as the result of learner

activity, i.e., individual sense-making and "construction" of viable solutions to problems encountered. (von Glasersfeld, 1991) In this context, it is understood that there is no single correct way of "understanding," that to observe is to interpret (Steedman, 1991). Problems are seen as situations to explore, with unexpected outcomes treated as opportunities to access and understand individual problem solving strategies or conceptualizations.

There is also an emphasis within constructivism on shared conceptualizations. It is recognized that cognitive structures are not formed in an individual vacuum, but are influenced according to the culture of which that individual is a member, the personality and motivation of the individual, previous learning experiences accrued (or not) by the individual, and expectations of self, peer groups, family, etc. It is the interaction of the community and the linguistic definitions it utilizes which shape and form the ideas that will emerge. Therefore, constructivism has the potential of a balanced framework which incorporates the elements of individual, classroom, cultural and pedagogical learning (von Glasersfeld, 1991).

Changes in Pedagogy, Methodology and Content in Mathematics Education

Co-emergent with the theory of constructivism have been the calls for reform at the level of classroom practice. Led by the NCTM, reformers sought to address the needs of a society in the midst of a technological and informational revolution, a society whose mathematics standardized test scores had continued to decline. Their objective was to outline standards and guidelines for use by teachers and school districts in their attempts to implement change (NCTM, 1989). Their focus was on (a) changes in philosophy (children must become confident in their ability to do mathematics, become mathematical problem-solvers, and learn to communicate

mathematically), (b) changes in content ("we do not assert that informational knowledge has no value, only that its value lies in the extent to which it is useful in the course of some purposeful activity" [p. 7]) and © changes in methodology ("research findings indicate that learning does not occur by passive absorption alone ")

Student Attitudes Toward Mathematics Learning

An underlying assumption of these new approaches to mathematics education is that learners will lay claim to their own mathematical knowledge, that they will become more motivated to participate in the active process of "knowing," of posing questions, of analyzing alternatives, of attempting to refine their own problem-solving and thinking processes. In other words, it is hoped that student attitudes toward mathematics and toward what activities one must engage in to be successful in mathematics will be effected.

One group of researchers studied an aspect of this affective dimension, that of learner goals and motivations, and learner beliefs about what makes one successful in mathematics (Nicholls, Cobb, Wood, Yackel & Patashnick, 1990). Nicholls, et al. stated that Asch and by Ausubel, Novak and Hanesian (cited in Nicholls, et al., 1990) had demonstrated that adults and older students (high school and junior high age) had personal achievement goals that could be characterized as either ego-oriented (in which success is defined as being superior to others) or as task-oriented (in which success is seen in terms of personal gains in understanding or insight or skill). This research demonstrated that these goal dimensions were independent of one another, rather than different expressions of the same dimension. The researchers also went on to identify a third orientation, that of work avoidance.

Nicholls and associates (1990) determined that these same goal dimensions were

perceptible in elementary students (in this case, second graders) and especially with regard to mathematics. Their research was conducted, in part, with the knowledge that better methods were needed for assessing student achievement within constructivist parameters and within NCTM Standards guidelines. The research by Nicholls and associates was a response to that need and the resultant goal analysis questionnaire was found to be a valid and reliable instrument for such work.

Cobb, et al. (1991) used the Nicholls, et al. (1990) instrument as one method (of several) to determine the effectiveness of teacher constructivist inservice activities on the students they teach. In a comparison of 10 project classes to eight non-project classes, research results indicated that the personal goals of the two groups were generally similar on the motivational measures of Effort, Understanding and Collaborating, and Work Avoidance, and on the scales administered for Reasons for Success, the project students demonstrated significant differences in four of the five scales. They believed more in the value of understanding/collaborating, and less in conforming to teacher definitions for success, competitiveness, and other extrinsic factors such as neatness, luck and being quiet in class. Therefore, with respect to student attitude, this study concluded that student beliefs and motivations in the constructivist classrooms had been modified by the socioconstructivist orientation of the instruction.

A follow-up study of the same students one year later confirmed that these motivations and beliefs about reasons for success remained oriented toward constructivism, although the students had been placed with other non-project students in non-constructivist, textbook-based classrooms (Cobb, Wood, Yackel & Perlwitz, 1992). In a comparison of former project students and non-project students who were placed together in third-grade classes based on reading scores,

researchers found that the two groups dealt with issues of being successful in mathematics in different ways. Project students placed a greater value on putting forth effort and doing their best (Effort B), on attempting to understand and collaborate (Understand and Collaborate B), and on developing meaningful solution methods that made sense (Conform B). The responses of the two groups were similar on the scales of Competition B and Extrinsic B. In addition, the responses of the two groups were similar on all scales which measured personal goals and motivations.

Other smaller scale studies which have also found that constructivist-oriented classrooms effect student attitudes. See, for example, Simon & Schifter (1993), Solomon, Maxwell & Ferraro (1994) and Rasch, Finch & Williams (1992).

Parent Attitudes Toward Mathematics Learning

Beyond the initial question of the effect of a constructivist curriculum on student attitudes, it was asked how the parents of the participating students might be interpreting the changes in their children's classrooms. This area proved more difficult to examine, the body of research much smaller.

There is a sizable body of literature covering the influence of parental attitudes on mathematical achievement, although the findings presented by the research are often contradictory. See, for example, studies by Eccles & Jacobs (1986), Elmore, Broadbooks, Pederson and Bleyer (1985), Pederson, Elmore and Bleyer (1986), Cain-Caston (1986), Parsons, Adler & Kaczala (1982), Horn & West (1992), Epstein (1988), and Wigfield (1983). One explanation for these contradictory findings may be the issues brought up by Epstein (1988). She pointed out the inadequacy of using correlations for analyzing questions of effect on students and other affective variables. The author stressed the need for longitudinal studies with

comprehensive data that measure changes in behaviors or achievements over time, with respect to the varying ability levels of the subjects. It would seem that what is needed for future affective research is clear definitions of the factors being analyzed, and guidelines for interpretation of the data presented.

Therefore, this thesis did not attempt to establish a correlation between the children's attitudes and the parents' attitudes. Rather, it is within a constructivist framework for research that the parent attitudes are considered important, indeed critical. Recognizing that individual learning takes place within a cultural and social context, that "mathematics" is seen to have evolved from agreed-on definitions and methods of operation (von Glasersfeld, 1991), and that the influences on the learners of mathematics go beyond those found only in the classroom (Dillon, 1993), it follows that the parents of these learners will have a large influence on the schooling activity that takes place. They are part of the cultural milieu which surrounds the individual learner and which therefore must be considered a crucial component of the learning process. Indeed, a look at the history of education, as well as literature within social learning theory, supports these claims.

Influences on Education Reform as Described by Histories of Education and Social Learning Theory

Much of the literature within two areas, the history of education and social learning theory, documents the prevailing cultural forces which have influenced and shaped educational reform throughout the last century.

Reese (1986) detailed the influences and struggles involved in the educational reform efforts of the early 1900s. He focused on the grass roots efforts of small community groups,

many led by parents, to share schooling decisions with the then-powerful corporate and elite groups in education. These activist grass roots groups included women who campaigned for suffrage and representation on school boards and fought for certain measures of social control, such as school lunches, supervised playgrounds, and health care. Other groups, more radical in nature, sought control in order to eliminate the sources of poverty and undemocratic government. Both groups sought changes concurrent with their view of schools as sites of social reform.

> Reformers of all political persuasions wanted to impose their values on the schools, and everyone realized that children would be controlled by the ruling ideas of specific adults. Schools existed to socialize youth, to train them in basic subjects, and to impose adult authority. Debates centered on whose values would predominate in the neighborhood school, not on whether imposition and social control would occur. This guaranteed that from the depression of the 1908s to the Palmer Raids of WWI, America's urban schools were largely contested terrain. (Reese, 1986, p. x)

Spring (1986), in his history of schooling, also emphasized the social learning theory aspect, portraying the institution of schools as one rife with conflict. These conflicts involved the "selection, classification and manipulation of student expectations, and often reflect(ed) the needs or beliefs of those in power within the hierarchy of the schools and society at large." (p. ix)

> The role of the school in American history can be understood from a variety of perspectives. On one hand, for many generations, immigrants, the poor, and minority groups have looked to the school to help them attain integration in the economic and social system of the United States. On the other hand, many people have attempted to use the school to restrict the advancement of certain social groups and as a means of control

> The history of education has often been a struggle between the people seeking to use the school for the purpose of domination and perpetuation of power and those seeking to use it to expand freedom and improve social conditions. (Spring, 1986, p. x)

Robitaille & Dirks (1981) have pointed out that this political influence on matters of curriculum often filters down directly to the mathematics classroom. They sought to explain the reasons why mathematics is taught in school, noting that mathematics curricular content is often selected on the basis of tradition, or in response to the latest curricular "fashion." These selections are influenced by a number of factors, including sociological, psychological, pedagogical and technological issues. One of the central points of their thesis is that any changes in mathematics curricula must be viewed with respect to the social and political landscape in which it was developed. "Mathematics education in any country cannot be divorced from politics, and we delude ourselves if we believe that this is not so." (Howson, quoted in Robitaille & Dirks, 1981, p. 9)

Fasheh (1982) presented examples of this phenomenon, emphasizing the critical interplay between cultural patterns of societal belief, thinking and behavior and that of mathematics instruction. Noting the "non-neutral" nature of mathematics and the subjective nature of its content, he detailed how the teaching of mathematics in Third World countries is often different from that which is taught in other areas of the world. For example, he noted the potential for mathematics to enhance critical thinking, self-expression, and cultural and social awareness, thereby often posing a threat to established institutions of power in the countries in which these ideas are taught. As a result, mathematics was rarely taught in a manner which demonstrates it to

be useful in those countries, and mathematics majors there were often conservative in their social outlook and "'timid' in their thinking and their analyses" (p. 2)

Anyon (1980) also demonstrated how cultural influences filter into the mathematics classroom by examining how varying social class values and beliefs effected the mathematics which was taught in classrooms in contrasting communities. In an analysis of two working-class schools, one middle-class school, one "affluent professional" school and one "executive elite school," Anyon detected certain social class roles and potential relationships between student and society already developing. Dependent on the school in question, teachers had different expectations of their students, both academically and behaviorally. Anyon saw these interactions as socially significant, speculating that these differing classroom "cultures" were actually preparing students for the real-life culture which awaited them when they left the schooling community (e.g., blue collar, white collar, etc.). She concluded:

> Differing curricular, pedagogical, and pupil evaluation practices emphasize different cognitive, pedagogical, and behavioral skills in each social setting and thus contribute to the development in the children of certain potential relationships to physical and symbolic capital, to authority, and to the process of work. (p. 90)

The teachers in these schools were carrying out the roles expected of them by their "social culture," a setting in which parents inherently reinforced these "understood" roles and felt comfortable with what was occurring in class. Therefore, although not quantified, the influence of the parents in these communities was palpable.

Useem (1992) provided some evidence of this influence. She found a high correlation in

two suburban communities between parents' education levels and their children's placement in mathematics classes. She noted that this correlation could be explained, in part, by the college-educated parents' propensity to be knowledgeable about their children's placement, to be integrated into school affairs and parental information networks, to intervene in educational decisions that school personnel made for their children, and to exert an influence over their children's preferences for courses. Useem concluded that it is this influence and involvement from parents at critical decision points that acts as one mechanism "by which educational advantage is transmitted from one generation to the next" (p. 263). Useem used the data to highlight the need for aggressive parental involvement efforts that reach parents from all socio-economic sectors.

What is stressed in this body of literature is that it is often parents who exert influence at the school level, at the district level, or at the state and national level to achieve changes in education that fit within their own belief systems about what is or is not appropriate in the school setting, or in the classroom. Thus, it is in this context that it becomes valuable to examine parent attitudes toward schooling and mathematics activity in school. Existing research demonstrates that parental beliefs are often inconsistent with the goals and activities of educators.

Parent Beliefs About and Attitudes Toward Education

Analysis of research results indicates several areas of concern with regard to the awareness by parents of key educational issues, and with regard to their own ability to interpret their child's academic performance.

For several years, the annual Phi Delta Kappa/Gallup Poll of the Public's Attitudes Toward the Public Schools (Elam & Rose, 1995; Elam, Rose & Gallup, 1996) has asked participants to

indicate their knowledge of current educational issues. The report stated in 1995 that "the public is distressingly uninformed about the education scene in America today" (Elam & Rose, 1995, p.43), and concluded in 1996 that the public's perception of educational issues "has been negatively affected by distorted, biased, or inadequate media coverage" (Elam, Rose & Gallup, 1996, p. 42). In the first poll, respondents ranked highest (as the most important educational issues) those items which had received the most media coverage - violence in the schools and drug abuse, while the issue of charter schools and school choice (at the time being tested in many states) was one about which they knew the least. In the most recent poll, respondents believed that student achievement in this country is seriously below those students of other developed nations, while in reality results have shown American students no worse than average in math and near the top in reading scores.

Other single-school studies demonstrate that parents often differ from the schools in their evaluation of their child's academic performance. See, for example, Waltman & Frisbee (1994), Office of Educational Research and Improvement (1992), Twillie, Petry, Kenney, Payne & Ashford (1992), and Wentworth & Connell (1994, 1995). Peressini (1995, 1996) conducted research in which, of those parents interviewed by researchers, most supported the essence of the changes being implemented in the mathematics classrooms of their children, but were unsure of the rationale, content and expected outcomes of the instruction. Peressini drew the contrast between the "look" of the constructivist classroom or the learning environment which it commands (emphasis on conceptual understanding, small groups which collaborate and discuss, more student responsibility for learning) with the traditional classroom in which they were educated (with emphasis on memorization of facts and algorithms, structured individual seatwork,

and teacher as responsible for transfer of learning). He pointed out that parents were often at cross-purposes with the teacher, showing their children "better ways" to solve the problems and thus discounting what was being taught in the classroom.

Peressini (1995) has quoted Cuban as saying that the classrooms with which most parents are familiar are those in which teachers had unquestionable control and authority, and in which assigned individual seatwork was the norm. These conventional classrooms were "characterized by a quiet sense of perseverance and monotony" (p. 1) and were very structured. Furthermore, many parents in the Peressini study voiced concern that they could not help their children who were struggling with mathematics, since they themselves (the parent) were unfamiliar with the curriculum, and were concerned that their children would not be prepared properly for college, or do poorly on the SAT test for college entrance.

Anderson and his colleagues (1994) found that the higher the socioeconomic level and the greater the college aspirations of students in a particular community, the greater was the resistance to mathematics and science reforms. Parents (and students) were uncomfortable with the shift from memorization and completion of problem sets to thinking critically about solution paths and connecting various aspects of the content. This was particularly true when they were concerned about their child's preparation for post-secondary education. A recent article by Kohn (1998) expands on this notion: "There is no national organization called Rich Parents Against Reform, in part because there doesn't have to be. But with unaffiliated individuals working on different issues in different parts of the country, the pattern is generally missed and the story is rarely told. The parents who prefer worksheets and lectures can use their clout to reverse or forestall a move to more learner-centered classrooms. Moreover, a tolerance for whole language

or cooperative learning often does not extend to the newer approaches to teaching math." (Kohn, 1998, p. 570)

It is in this context, then, that it becomes more clear how the role of parents and parental beliefs is central to the question of influence in the classroom. Schooling, when viewed as a political institution, is an arena in which organizations, grass roots movements, and special interest groups can have a large impact, and it is the parents whose children are effected by this institution who mobilize to take action. This phenomenon continues today, and, many would say, is more powerful than ever, particularly with regard to mathematics education.

Therefore, a central question posed by this thesis was to ask whether parents' beliefs and goals toward mathematics learning were oriented similarly to those of their children. In other words, were parents of children who were exposed to constructivist activity and teaching in the classroom more task-oriented (and thus supportive of that activity) than those parents whose children were involved with more traditional mathematics classrooms?

Hypothesis

It was predicted that there would be no significant difference on the instrument items associated with task orientation (Scale 1 and Scale 2 of the Personal Goals/Motivation instrument and Scales 1 and 2 of the Beliefs About Reasons for Success) between the students who were enrolled in the constructivist-oriented classrooms and their non-project peers who were enrolled in non-constructivist classrooms. Furthermore, it was expected that these same students would not rank significantly lower (or higher) those items associated with ego orientation and work avoidance. Scales 3 and 4 of the Personal Goals/Motivation instrument, and Scales 3, 4 and 5 of

the Beliefs About Reasons for Success instrument.

With regard to the results of the parent surveys, it was expected that there would be no significant difference on any of the scale items between the two groups of parents (project and non-project), i.e., that the constructivist-student parents would not score the task orientation, ego-orientation, or work avoidance items differently than their non-constructivist-student parent counterparts. Moreover, it was expected that those parents who attended the teacher-initiated "Family Math Nights" would not score significantly differently any of the scale items than their project parent counterparts who did not attend these sessions.

Method

Subjects

The subjects in this study were 542 students drawn from 33 classrooms at three elementary schools in a community composed of mostly middle- to upper-class families which were almost exclusively Caucasian. The students had been randomly assigned to the 33 classes at the start of the school year. All students present in these classes on the days of administration of the questionnaire participated in the study.

In addition, to obtain subjects for the parent segment of the study, all of the participating students (project and non-project) were given parent questionnaires to carry home, accompanied with a letter asking one parent to participate. Assuming that all questionnaires were delivered to the parents, 452 parents received the instrument.

Experimental subjects in the study were those children in classrooms whose teachers had volunteered to participate in a research project conducted by professors from Kent State

University (the Kent State research was conducted to pilot constructivist curriculum materials as part of a pre-publication analysis). The teachers were asked to volunteer to participate in this pilot study in order to aid the local school district in upcoming decisions regarding the adoption of new mathematics curriculum materials. A total of 12 teachers participated: two from 2nd grade, two from 3rd grade, five from 4th grade, and three from 5th grade. These teachers received constructivist-based curriculum materials in the fall of 1995, as well as approximately 56 hours of inservice training on how to teach and facilitate learning with these materials. The curriculum materials under examination were entitled Investigations in Number, Data and Space (Technical Education Research Council [TERC], 1996).

The TERC materials utilized by the project teachers represent a curriculum which is based on a constructivist epistemology, and which supports NCTM standards. Funded by the National Science Foundation, they support a shift in the mathematics classroom toward mathematical reasoning and the description, comparison, and discussion of contrasting problem-solving strategies. To this end, teachers in the experimental classrooms worked to change student perceptions about their role, the role of the teacher, and appropriate mathematics classroom activities. Thus, the independent variable involved in this study was the constructivist-based teaching practices and curriculum materials utilized in the classroom.

Twelve classes were chosen as the control group. These classes were selected at random from the total group of classes which had not utilized the TERC curriculum materials. The grade makeup of these classes was as follows: two from 2nd grade, two from 3rd grade, four from 4th grade, and four from 5th grade. The control group of subjects utilized a traditional textbook series (Exploring Mathematics, 1991) and the teachers received no special training as to the

curriculum's use. Whole-class instruction was typical in these classrooms, with adherence to the lessons and activities as outlined by the text. There was emphasis placed on individual seat-work, arriving at one right answer, and copying the teacher- or text-demonstrated methods for problem-solving.

The parent control and experimental subjects were those parents whose children were in the control or experimental groups, respectively. There were no formal planned activities for educating project parents as to the pedagogy supporting the constructivist materials. However, teachers informed parents at the beginning of the year about the general nature of the materials, and sent letters home throughout the school year.

Three of the project teachers held "Family Math Nights" on their own, evenings in which students were invited to bring their parents to class and to demonstrate some of their mathematics activities and lessons. Parent turnout was calculated to be over 75% and the parent reaction was considered by the teachers to be overall a positive one.

Instruments

The dependent variables measured in the study were two aspects of parent/student attitudes toward the nature of mathematics and mathematics learning activities. The first concerned learner beliefs about what mathematical activities one needs to engage in to be successful in mathematics. The second aspect measured the student's (or the parent's) personal goals and/or motivations with regards to mathematics.

Nicholls, et al. (1990) found that the same dimensions of personal achievement goals present in adults and in older students could be detected in second grade mathematics students. These dimensions included task orientation, ego orientation and work avoidance. "Task

orientation involves a self-referenced definition of success as the gaining of insight or skill or accomplishing something that is personally challenging. Ego orientation ... means that to experience success the student must establish his or her ability as superior to that of others." (p 110) Work avoidance involves a motivation or tendency to do that which is easiest or requires the least amount of effort.

Furthermore, Nicholls, et al. (1990) found that these dimensions of personal goals were related to the students' beliefs about causes of success. These two aspects of student attitude (motivation and beliefs about reasons for success) converged and resulted in different personal criteria for success.

The resultant instrument was later refined and utilized by Cobb, et al. (1991) and was again employed for follow-up assessment by Cobb et al. (1992).

The first section of the survey, as described in the above studies, assessed subjects' motivational orientations or personal goals employed during mathematics instruction. The four scales used to measure motivation/personal goals, along with their reliability data, are listed in Table 1.

Table 1

Personal Goals Scales

(The stem for all items is, "I feel really pleased in math when ")

1) Effort M (Cronbach Alpha = .78)
I solve a problem by working hard.
The problems make me think hard.
What the teacher says makes me think.
I keep busy.
I work hard all the time.

2) Understand and Collaborate M (Cronbach Alpha = .71)
Something I learn makes me want to find out more.
I find a new way to solve a problem.
Something I figure out really makes sense.
Everyone understands the work.
We help each other figure things out.
Other students understand my ideas.

3) Ego M (Cronbach Alpha = .83)
I know more than my classmates.
I finish before my classmates.
I get more answers right than my classmates.
I am the only one who can answer a question.

4) Work Avoidance M (Cronbach Alpha = .79)
It is easy to get the answers right.
I don't have to work hard.
All the work is easy.
The teacher doesn't ask hard questions.

Students were asked to circle an answer which best described their feeling or opinion: "YES, yes, ?, no, NO" (with the two extreme options in bold type). These responses corresponded to a five-point scale in which 1 = "NO" or "strongly disagree" and 5 = "YES" or "strongly agree."

Scales 1 and 2 corresponded to the aspect of Task Orientation, Scale 3 corresponded to the aspect of Ego Orientation and Scale 4 regarded the aspect of Work Avoidance.

The second set of scales assessed subjects' beliefs about the activities one must engage in to be successful at mathematics. The five scales utilized in this assessment are listed in Table 2 along with their Cronbach Alpha reliabilities.

Table 2
Beliefs About the Reasons for Success Scales

(The stem for all items is, "Students will do well in math if...")

1) Effort B (Cronbach Alpha = .71)
- They work really hard
- They always do their best
- They like to think about math
- They are interested in learning

2) Understand and Collaborate B (Cronbach Alpha = .62)
- They try to explain their ideas to other students.
- They try to understand each other's ideas about math.
- They try to understand instead of just getting answers to problems.
- They try to figure things out.
- They don't give up on really hard problems.

3) Conform B (Cronbach Alpha = .76)
- They solve the problems the way the teacher shows them and don't think up their own ways.
- They all solve the problems the same way and don't think up different ways.
- They try to find their own ways of doing problems. *
- They like to find different ways to solve problems. *

4) Competitiveness B (Cronbach Alpha = .67)
- They try to get more things right than their classmates.
- They try to do more work than their classmates.
- They are smarter than their classmates.

5) Extrinsic B (Cronbach Alpha = .58)
- They are just lucky.
- Their papers are neat.
- They are quiet in class.

* The scores on these items were reversed for data analysis (the wording of the item elicited a response opposite that of previous items, i.e., a score of "1" indicated disagreement with the premise of conformity, whereas a "1" on the previous items indicated agreement. Please note wording.)
As described above, students responded to each item using a five-point scale.

Procedures

Individual classroom teachers administered the surveys to their students during the month of February 1996. Each teacher was given the same set of instructions which they were asked to read to their classes. These instructions stated the purpose of the study--to gather information about student attitudes toward success in mathematics--and stressed that the results would be confidential and would not be used in any way for individual teacher evaluations. The need for valid data was stressed, and thus the need for each teacher to read the instructions as they were written.

The parent surveys were handed out to the participating students on the same day as the administration of the student survey, with instructions that they were to be carried home to the parents. Included with the parent surveys was a cover letter detailing the purpose of the survey and instructions as to how the instrument was to be filled out. These instructions stressed that only one parent should complete the survey, and that the questions should be answered with regard to what that parent believed their child should do to be successful, or what should motivate their child to do well, rather than with regards to what their own personal school experiences had been.

The surveys were color-coded to indicate in which group, experimental or control, the students (and their parents) had participated. In addition, the surveys of those classes which had held "Family Math Nights" were marked in order to facilitate separate analysis of that data.

Data Analysis and Results

A total of 542 student surveys were completed. 266 project (or experimental) and 276 non-project (or control).

Out of 542 parent surveys carried home, a total of 314 surveys were completed and returned to school. 165 project, and 149 non-project.

Student responses to each of the five beliefs scales and the four personal goals scales were analyzed and compared by using a two-tailed t-test for independent samples between project and non-project scores. The results are listed in Table 3. Higher scores indicate agreement and lower scores, disagreement.

Table 3

Student Means (and Standard Deviations) and T-Statistics on Personal Goals and Beliefs About Reasons for Success in Mathematics

	Project	Non-Project	T-Statistic
Personal Goals/Motivation			
1. Effort M	3.91(1.07)	3.78(1.13)	3.09**
2. Undstd/Collab M	4.14(0.96)	3.91(1.10)	6.21**
3. Ego M	2.91(1.30)	3.16(1.37)	-4.32**
4. Work Avoid M	2.84(1.38)	3.11(1.42)	-4.58**
Beliefs About Reasons for Success			
1. Effort B	4.41(0.85)	4.18(1.05)	4.47**
2. Undstd/Collab B	4.32(0.88)	4.19(0.93)	3.77**
3. Conform B	1.96(1.12)	2.43(1.26)	-9.09**
4. Competitiveness B	2.67(1.25)	2.95(1.24)	-4.47**
5. Extrinsic B	2.74(1.40)	2.89(1.43)	-2.13*

Note: n=266 project students and 276 non-project students
*p<0.02
**p<0.01

Analysis of this data indicated that a significant treatment effect occurred on all scales for

the project students. Project students were significantly more oriented toward tasks, i.e., to work hard (Effort M) and to understand and collaborate (Understand and Collaborate M), and were less oriented toward the ego aspect (Ego M), or toward work avoidance (Work Avoidance M).

Likewise, on the Beliefs About Reasons for Success scales, project students clearly believed that effort (Effort B) and understanding/ collaborating (Understand & Collaborate B) would result in success in mathematics, and that conforming to teacher solutions (Conformity B), competing with classmates (Competitiveness B), or focusing on outside factors such as neatness or luck (Extrinsic B) would not.

Parent responses to the scale questions were also analyzed using a two-tailed t-test comparison between project and non-project responses. The results are listed in Table 4, again with the higher scores indicating agreement, and the lower scores, disagreement.

Table 4

Parent Means (and Standard Deviations) and T-Statistics
on Their Child's Personal Goals and Beliefs About Reasons for Success in Mathematics

	Project	Non-Project	T-Statistic
Personal Goals/Motivation			
1. Effort M	3.34(1.32)	3.26(1.33)	1.18
2. Undstd/Collab M	3.72(1.05)	3.61(1.13)	2.18*
3. Ego M	3.26(1.16)	3.18(1.18)	1.12
4. Work Avoidance M	3.44(1.36)	3.40(1.35)	0.54
Beliefs About Reasons for Success			
1. Effort B	3.08(1.18)	3.10(1.19)	-0.29
2. Undstd/Collab B	3.43(1.28)	3.38(1.29)	0.77
3. Conform B	2.45(1.02)	2.47(1.04)	-0.24
4. Competitiveness B	3.77(0.89)	3.69(0.93)	1.47
5. Extrinsic B	3.62(0.99)	3.60(1.01)	0.27

Note: n=165 project parents and 149 non-project parents
*$p<0.05$

The parent survey responses revealed less of a treatment effect than did those of their

children. A significant effect was detected on only one scale between project and non-project parents, that of Understand & Collaborate M, the Personal Goals/Motivation scale. This would indicate that parents would like their children to be motivated by understanding and collaboration, but the low t-score for the Understand & Collaborate B scale (0.77) seems to indicate that they do not necessarily believe that this will cause their children to be successful in mathematics. On all other scales, there was no significant treatment effect between parents of project students and parents of non-project students.

Three of the project classroom teachers had held "Family Math Night" for their parents in an attempt to educate and inform them about the constructivist activities in which their child was participating. The survey scores of these parents were separated from the remaining project parents and analyzed. The results are listed in Table 5 below.

Table 5

"Math Night" Parent Means (and Standard Deviations) and T-Statistics on Their Child's Personal Goals and Beliefs About Reasons for Success in Mathematics

	Math Night	No Math Nt	T-Statistic
Personal Goals/Motivation			
1. Effort M	3.30(1.32)	3.36(1.33)	-1.03
2. Undstd/Collab M	3.69(1.04)	3.73(1.06)	-0.94
3. Ego M	3.28(1.16)	3.25(1.16)	0.68
4. Work Avoidance M	3.53(1.33)	3.41(1.37)	1.97*
Beliefs About Reasons for Success			
1. Effort B	3.13(1.14)	3.06(1.20)	1.26
2. Undstd/Collab B	3.42(1.26)	3.43(1.29)	-0.05
3. Conform B	2.58(1.03)	2.41(1.02)	3.61*
4. Competitiveness B	3.80(1.03)	3.66(0.97)	-2.89*
5. Extrinsic B	3.62(0.99)	3.60(1.01)	0.27

Note: n=49 "Math Night" parents and 116 non-"Math Night" parents. *$p<0.05$

These results indicated that no treatment effect occurred as a result of the parent education efforts. Only three scales demonstrated a treatment effect, and two of these three resulted in opposite findings of what was expected. On both Scale 4 of the Personal Goals/Motivation scale (Work Avoidance) and on Scale 3 of the Beliefs About Reasons for Success "Math Night" parents scored the items higher than non-Math Night parents. Math night parents did score significantly lower on one scale than did non-math night parents, Scale 5 of Beliefs About Reasons for Success: Extrinsic factors (t-score was -2.89).

Discussion

This study investigated the effects of the adoption of a constructivist-oriented epistemology and pedagogy on the beliefs and motivations toward mathematics of the students who were exposed to the curriculum, and likewise on the beliefs and motivations of the parents of these same students. The results were then used to situate the findings within a larger social and political realm of educational reform activism.

The results of the study confirmed the earlier findings of Cobb, Wood, Yackel, Nicholls, et al. (1991) and Cobb, Wood, Yackel, Perlwitz, et al. (1992) that constructivist-oriented classroom activity, curricula, and teacher inservice result in attitudes in students that are more strongly oriented toward the task, and away from ego and work avoidance. The students in this study who were enrolled in the constructivist-oriented classes scored significantly higher on every scale which measured task orientation, and lower on those which measured ego, work avoidance, or extrinsic, than their non-project student peers. Therefore, it was concluded that these students strongly believed in the value of working harder to make sense of solutions, of collaboration with

peers, and understanding different problem-solving methods, and that these activities would result in success in mathematics, both for themselves personally (the goal scales) as well as for others (beliefs about reasons for success scales).

The parents of these project students, on the other hand, scored the scale items very differently. Responses to the scale questions indicated that the group of parents as a whole, regardless of which classroom orientation their child experienced (constructivist or traditional), held similar beliefs about reasons for success in mathematics. They were more ego-oriented in their responses, placing more emphasis on competition, and conforming to the solutions of others. Their indicated viewpoints fit with a more traditional didactic model of learning, consistent with the results of data gathered by Wentworth & Connell (1994), and indicated a comfort with more familiar traditional classroom activity consistent with the findings of Peressini (1995).

Furthermore, efforts on the part of individual teachers to educate parents during "Family Math Nights" were ineffective in orienting these same parent beliefs and motivations toward task orientation. Data analysis indicated that there was no difference between those constructivist parents who attended Math Night and the constructivist parents who did not.

It is to be noted that a possible limitation to this data is that the parents who participated in these "Math Night" activities volunteered to attend, and therefore did not necessarily constitute a representative sample of project parents. In addition, the teachers who decided to conduct these parent education activities were those teachers who felt the most comfortable with the curriculum and the mathematics activities it involved.

When asked to write subjective comments about their beliefs about mathematics, an informal ranking analysis revealed that parents wanted and/or supported the nature of the

mathematics reforms being attempted. They emphasized the importance of more real life examples, more emphasis on problem solving and the processes of mathematical thinking, and the professionalism of teachers. A possible limitation of this data is that these subjective written comments could have been swayed by the nature of the wording of the objective questions included on the same instrument. Many written responses addressed the same issues targeted by the scale questions: collaborative activity in the classroom, putting forth individual effort, conforming to the solutions of others. There were other written responses, however, which departed from the issues of the instrument to address other concerns such as the amount of homework, teacher professionalism and accountability, and communication between home and school.

Other possible limitations to the study include the fact that participating teachers volunteered for the pilot program, thus opening the possibility that these were the mathematics teachers who were supportive of the changes taking place. They were highly motivated to succeed, were convinced of the value of the pedagogy, and thus could have possibly achieved the same results regardless of the curriculum utilized.

Lastly, any interpretation of this data needs to take into account the socio-economic and racial makeup of the surrounding community: mostly upper-middle- to upper-class families which were 97% Caucasian. Any application of this data, then, must bear these limitations in mind.

Yet, the findings of this study were consistent with those of Wentworth & Connell (1994, 1995) discussed earlier: parents supported more the explicit role of education (finding a good job, gaining skills) than the implicit role (becoming better problem-solvers, helping to reach individual potential) and felt uncomfortable when computers were used to reinforce and facilitate

innovative mathematics instruction. They found that parents were more comfortable with and supportive of computer use in the classroom when it reinforced their notions of teacher roles: that of a purveyor of information (reinforcing basic skills) rather than as a facilitator of learning (development of problem-solving ability).

The findings of this study were also consistent with the research findings of Peressini (1995) in which most parents were supportive of the broad nature or philosophy of change occurring in mathematics education, but were unsure of and not always supportive of the rationale, content and expected outcomes of the classroom activities and/or curricula.

These studies viewed collectively with the data gathered in this research offer a view of parents as unfamiliar or uncomfortable with effective classroom methodologies (i.e., group collaborative efforts), with the recommended changes in mathematics content (i.e., new/different types of math being taught such as probability, statistics, etc.), and in some cases with the philosophy or reasons why the changes are being proposed at all. Parents are seen as having certain set beliefs about what a mathematics lesson or class should "look like," and many find it difficult to change their frame of reference away from a didactic model of knowledge transference.

Parent Objections and Reactions to School Reform

Perhaps it is, then, that objections should be expected by those districts and school officials who will make attempts at curriculum reform. This, however, should be cause for concern since parent goals with regards to education often differ from those of the school's (Peressini, 1995; Wentworth & Connell, 1994; Dillon, 1993) and even from those of student or child (Cobb, et al., 1991). It should be cause for concern because it is often these differences in

ideology that cause conflict between parents and schools, and can translate into political or social activism against well-intentioned school reform efforts. As elaborated in much of the social learning literature (Reese, 1986; Apple, 1990; Spring, 1986; Useem, 1992), this type of parental influence on the schools can be a powerful force.

There are many specific examples of the effects of parental influence at all levels. Their activities range from questioning (and ultimately reversing) curricular decisions made at the school level by teachers and administrators (McDiarmid & Kleinfeld, 1992; Dillon, 1993), to pressuring lawmakers for legislative control over curricular matters at the state level (Colvin, 1996), to nationally-organized groups which provide guidance and support for political candidates and activists who seek to influence education reform efforts (Mutchler, 1993).

Anderson's research (1995) confirmed how effective these activist campaigns can be. He found that "the resistance from parents (to educational reform) in some cases was serious enough to compromise the reforms" (p. 35). In addition, Apple (1990) has pointed out that curricular specialists are not accustomed to challenges by their constituents, and that the entire culture of schooling has typically operated with a belief that "education is unconnected to economic, political and ideological conflicts and that (they) can solve (their) problems by looking only within the school" (p. 530). Thus the combination of parent activism with the unpreparedness of schools to handle such interactions has more and more resulted in a shift of power to those whose sentiments lie decidedly elsewhere than with innovative school reform. Dillon (1993) summarizes this dilemma:

> It appears that parents and community leaders can play a powerful and often unpredictable role in influencing educational change. Parents, in an attempt to help their own child,

> often neglect the total picture of teaching and learning and school reform efforts. Board members...are often guided by the loudest voices rather than by the many voices of parents, teachers, students, and administrators. (p. 95)

These "loudest voices" to which Dillon referred are increasingly coming from those who espouse conservative ideologies. The concerns of these activists are distinguishable from the past activist movements (outlined by Reese, 1986) by their tone and emphasis (Mutchler, 1993). Mutchler has written that

> America is in the midst of a culture war that has had and will continue to have reverberations not only within public policy but within the lives of ordinary Americans everywhere... What is at stake in this cultural conflict is the definition and expression of public morality in the nation's social institutions, including the education system. (Hunter, quoted by Mutchler, 1993, p. 4).

Apple (1990) placed these conflicts over school curricular decisions into a context of larger social reform. He noted the shift in emphasis by activists: no longer is the social democratic goal of expanding equality of opportunity appealing to education reform activists (as it was to activists 20 years ago). These conservative reformers are concerned more with the moral direction of the country, and they see evidence of its decline within school systems run by "liberal intellectuals." He wrote:

> The prevailing concerns today -- panic over falling standards and rising rates of illiteracy, the fear of violence in the schools, and the perceived destruction of family and religious

values -- have allowed culturally and economically dominant groups to move the arguments about education into their own arena by emphasizing standardization, productivity, and a romanticized past when all children sat still with their hands folded and learned a common curriculum. Parents are justifiably concerned about their children's future in an economy that is increasingly conditioned by lower wages, the threat of unemployment, and cultural and economic insecurity -- and the neoconservative and rightist positions address these fears. (p.527)

The observations and conclusions of these theorists allow the educational community to be viewed within the larger social context in which it functions, and to frame the activity surrounding educational change in a manner that is more representational of actual events and their effects. Thus we see more clearly that either through grass roots efforts of their own, or by supporting larger efforts of groups that address their concerns, how it is that parents can have a dramatic impact on the reform efforts set forth by teachers and administrators.

It would seem, then, that schools must be willing to consider the broader social, cultural and political forces which influence and shape what occurs in the classroom. The desired outcome, beyond the changes sought at the classroom level, is parent support and involvement based on reliable information and solid educational research. Several researchers have addressed the responsibilities of education decision-makers in these areas, and have raised concerns regarding perceived shortcomings of many school reform efforts, including the NCTM standards for mathematics. See, for example, Peressini (1996), Apple (1992), Dillon (1993), Mutchler (1993), and Arnsparger & Ledell (1993).

Conclusions

Ongoing research in the field of mathematics education will need to take into account more effectively the critical elements of social, cultural and political influences on schooling. The data from this study indicated that solid, research-based, teacher-implemented reform measures to which students respond positively will not necessarily be viewed in this same manner by parents and/or community members. Parents often rely on older, familiar frames of reference by which to judge educational reform activity, and are often uninformed or excluded from the decision-making and implementation process. In other cases, parents may look to schools with a wary eye, harboring concerns about the nature and direction of society in general.

This study indicated that these parental perceptions and frames of reference are difficult to penetrate, and that information dissemination or organized parent involvement activities (such as Family Math Nights) may not be enough. Future research will need to consider these elements in a more in-depth manner, and to identify effective methods of reform activities which are inclusionary of the wider social and political spectrum surrounding them. This research, in other words, must work to eschew the constructivist ideals which it espouses in the classroom for teachers and children, ideals which recognize the larger cultural milieu around the complex process of learning and knowledge acquisition.

What is desired, it seems, is a mutual and symbiotic relationship between parents and the schools in which informed parents are supportive and encouraging of research-based methods and content for their children, and in which the larger school "culture" or community is receptive to and welcomes the input of its parent constituency. Failure by schools to accomplish these goals may result in the further erosion and eventual loss of control over that which educators hold most

sacred -- decisions and power over matters of curriculum, pedagogical and epistemological improvement.

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